

**WHAT IS CLAIMED IS:**

1        1.     A method for restoring a virtual path in an optical network, the method  
2 comprising:  
3                identifying a plurality of nodes with resources, wherein said nodes with  
4                resources are ones of said nodes having a resource necessary to support  
5                said virtual path; and  
6                identifying an alternate physical path, said alternate physical path comprising  
7                ones of said nodes with resources.

1        2.     The method of claim 1, further comprising:  
2                restoring said virtual path using said alternate physical path.

1        3.     The method of claim 2, wherein said restoring is done by  
2                configuring said alternate physical path by establishing a communication  
3                connection between said ones of said nodes with resources; and  
4                provisioning said virtual path over said alternate physical path.

1        4.     The method of claim 2, further comprising:  
2                detecting a failure in said virtual path;  
3                said detection of said failure is done by receiving a failure message packet;  
4                said virtual path is provisioned on a physical path between a first and a second  
5                node of said optical network;  
6                said optical network comprises said nodes;  
7                each one of said nodes is coupled to at least one another of said nodes by a  
8                plurality of optical links;  
9                said physical path between said first and said second node comprises a  
10                plurality of intermediate nodes; and  
11                each one of said nodes is coupled to at least one another of said nodes in a  
12                mesh topology.

1        5.     The method of claim 4, wherein said restoring of said virtual path is  
2 completed in less than 2 seconds.

1       6.     The method of claim 4, wherein said restoring of said virtual path is  
2 completed in less than 250 milliseconds.

1       7.     The method of claim 4, wherein said first node receives said failure  
2 message packet.

1       8.     The method of claim 7, further comprising:  
2           (i)    changing a state of said virtual path to restoring;  
3           (ii)    identifying an adjacent node with required bandwidth for said  
4                 virtual path;  
5           (iii)   forwarding a resource request packet to said adjacent node with  
6                 required bandwidth for said virtual path;  
7           (iv)    waiting for a resource response packet for a predetermined time  
8                 interval; and  
9                 if said resource response packet is not received within said predetermined  
10                time interval,  
11                 repeating steps (ii) – (iv) for a predefined threshold times.

1       9.     The method of claim 8, further comprising:  
2                 if said resource response packet is not received within said predefined  
3                 threshold time,  
4                 generating a network alarm.

1       10.    The method of claim 8, further comprising:  
2                 if said resource response packet is received with at least one error,  
3                 waiting until responses to all resource request packets are received; and  
4                 if said resource response packet is received with no errors,  
5                 determining if a list of allocated ports in said resource response packet  
6                 is valid.

1       11.    The method of claim 10, further comprising:  
2        if said list of allocated port is valid,  
3               provisioning said virtual path on said allocated ports; and  
4        if said list of allocated ports is invalid,  
5               generating a network alarm.

1       12.    The method of claim 10, further comprising:  
2        if responses to all resource request packets are received with at least one error,  
3               generating a network alarm.

1       13.    The method of claim 9, wherein said predetermined time interval and  
2        predefined threshold are dynamically calculated by said network.

1       14.    The method of claim 4, wherein one of said intermediate nodes  
2        receives said failure message.

1       15.    The method of claim 14, further comprising:  
2        changing a state of said virtual path to down;  
3        forwarding said failure message to adjacent nodes comprising said virtual  
4               path;  
5        initiating a timer for receiving a response to said forwarded failure message;  
6        if said timer expires before said response to said forwarded failure message is  
7               received,  
8               releasing resources of said virtual path; and  
9        if said response to said forwarded failure message is received before said timer  
10               expires,  
11               stopping said timer, and  
12               releasing resources of said virtual path.

13  
1       16.    The method of claim 4, wherein said second node receives said failure  
2        message.

1       17. The method of claim 16, further comprising:  
2       acknowledging said failure message;  
3       changing a state of said virtual path to down; and  
4       releasing resources of said virtual path.

1       18. The method of claim 18, wherein one of said intermediate nodes  
2       receives said resource request packet.

1       19. The method of claim 18, further comprising:  
2       if said resource request packet includes at least one error,  
3               copying said resource request packet to a first resource response  
4               packet,  
5               decrementing a hop count field in said first resource response packet,  
6               adding an error code to said first resource response packet, and  
7               responding with said first resource response packet; and  
8       if said resource request packet includes no errors,  
9               allocating a resource to said virtual path,  
10          incrementing a hop count field in said resource request packet,  
11          forwarding said resource request packet to an adjacent node having a  
12               resource necessary to support said virtual path, and  
13               waiting for a second resource response packet from said adjacent node.

1       20. The method of claim 19, further comprising:  
2       if said second resource response packet is not received within a predetermined  
3               time interval,  
4               releasing said resource allocated to said virtual path, and  
5               forwarding a negative acknowledgment to said first node.

1       21. The method of claim 19, further comprising:  
2       if said second resource response packet is received with at least one error,  
3           releasing said resources allocated to said virtual path,  
4           decrementing a hop count field in said second resource response  
5           packet, and  
6           forwarding said second resource response packet to said first node; and  
7       if said second resource response packet is received with no errors,  
8           determining if said second resource response packet includes a valid  
9           list of a plurality of ports.

1       22. The method of claim 21, further comprising:  
2       if said list of said plurality of ports is invalid,  
3           releasing resources allocated to said virtual path, and  
4           forwarding a negative acknowledgement to said first node;  
5       if said list of said plurality of ports is valid,  
6           determining if said plurality of ports is available;  
7       if said plurality of ports is available,  
8           assigning said plurality of ports to said virtual path, and  
9           updating said virtual path information in a node database;  
10      if said plurality of ports is not available,  
11           adding an error code to said second resource response packet;  
12      decrementing a hop count field in said second resource response packet; and  
13      forwarding said second resource response packet to said first node.

1       23. The method of claim 18, further comprising:  
2       if a state of said virtual path is one of ‘restoring’ and ‘deleting’,  
3           copying said resource request packet to said first resource response  
4           packet,  
5           decrementing said hop count field in said first resource response  
6           packet,  
7           adding an error code of to said first resource response packet, and  
8           responding with said first resource response packet.

1        24. The method of claim 8, wherein said second node receives said  
2 resource request packet.

1        25. The method of claim 24, further comprising:  
2        if said resource request packet includes invalid information,  
3                copying said resource request packet to a third resource response  
4                packet,  
5                decrementing a hop count field in said third resource response packet,  
6                adding an error code to said third resource response packet, and  
7                responding with said third resource response packet; and  
8        if said resource request packet includes valid information,  
9                determining if a resource is available for said virtual path.

1        26. The method of claim 25, further comprising:  
2        if said resource is available for said virtual path,  
3                copying said resource request packet to said third resource response  
4                packet,  
5                allocating said resource to said virtual path,  
6                updating said virtual path information in a node database,  
7                decrementing a hop count field in said third resource response packet,  
8                adding a list of a plurality of ports to said third resource response  
9                packet, and  
10          responding with said third resource response packet.

1        27. The method of claim 25, further comprising:  
2        if said resource is not available for said virtual path,  
3                copying said resource request packet to said third resource response  
4                packet,  
5                decrementing said hop count field in said third resource response  
6                packet,  
7                adding an error code to said third resource response packet, and  
8                responding with said third resource response packet.

1       28. The method of claim 24, further comprising:  
2       if a state of said virtual path is one of ‘restoring’ and ‘deleting’,  
3           copying said resource request packet to said third resource response  
4           packet,  
5           decrementing said hop count field in said third resource response  
6           packet,  
7           adding an error code to said third resource response packet, and  
8           responding with said third resource response packet.

1       29. A network element configured to restore a virtual path in an optical  
2       network, the network element comprising:  
3           a processor;  
4           a memory coupled to said processor; and  
5           a network interface coupled to said processor; said processor configured to  
6           identify a plurality of nodes with resources, wherein said nodes with  
7           resources are ones of said nodes having a resource necessary to  
8           support said virtual path, and  
9           identify an alternate physical path, said alternate physical path  
10           comprising ones of said nodes with resources.

1       30. The network element of claim 29, wherein said processor is further  
2       configured to  
3           restore said virtual path using said alternate physical path.

1       31. The network element of claim 29, wherein said processor is further  
2       configured to  
3           configure said alternate physical path by establishing a communication  
4           connection between said ones of said nodes with resources; and  
5           provision said virtual path over said alternate physical path.

1       32. The network element of claim 29, wherein said processor is further  
2 configured to  
3       detect a failure in said virtual path;  
4       said detection of said failure is done by receiving a failure message packet;  
5       said virtual path is provisioned on a physical path between a first and a second  
6               node of said optical network;  
7       said optical network comprises said nodes;  
8       each one of said nodes is coupled to at least one another of said nodes by a  
9               plurality of optical links;  
10      said physical path between said first and said second node comprises a  
11               plurality of intermediate nodes; and  
12      each one of said nodes is coupled to at least one another of said nodes in a  
13               mesh topology.

1       33. The network element of claim 32, wherein said processor is further  
2 configured to restore said virtual path in less than 2 seconds.

1       34. The network element of claim 32, wherein said processor is further  
2 configured to restore said virtual path in less than 250 milliseconds.

1       35. The method of claim 32, wherein  
2       said network element is configured as said first node; and  
3       said network element receives said failure message packet.

1       36. The network element of claim 35, wherein said processor is further  
2 configured to  
3               (i) change a state of said virtual path to restoring;  
4               (ii) identify an adjacent node with required bandwidth for said  
5                       virtual path;  
6               (iii) forward a resource request packet to said adjacent node with  
7                       required bandwidth for said virtual path;  
8               (iv) wait for a resource response packet for a predetermined time  
9                       interval; and

10 (v) if said resource response packet is not received within said  
11 predetermined time interval,  
12 repeat steps (ii) – (iv) for a predefined threshold times.

1                   37.    The network element of claim 36, wherein said processor is further  
2    configured to

3 if said resource response packet is not received within said predefined  
4 threshold time,  
5 generate a network alarm.

1                   38.     The network element of claim 36, wherein said processor is further  
2     configured to

3 if said resource response packet is received with at least one error,  
4 wait until responses to all resource request packets are received; and  
5 if said resource response packet is received with no errors,  
6 determine if a list of allocated ports in said resource response packet is  
7 valid.

1                   39.     The network element of claim 38, wherein said processor is further  
2     configured to

- 3                   if said list of allocated port is valid,  
4                   provision said virtual path on said allocated ports; and  
5                   if said list of allocated ports is invalid,  
6                   generate a network alarm.

1                  40.     The network element of claim 38, wherein said processor is further  
2     configured to

3           if responses to all resource request packets are received with at least one error,  
4            generate a network alarm.

1           41.     The network element of claim 39, wherein said predetermined time  
2 interval and predefined threshold are dynamically calculated by said network.

1       42. The network element of claim 4, wherein  
2       said network element is configured as one of said intermediate nodes, and  
3       said network element receives said failure message.

1       43. The network element of claim 42, wherein said processor is further  
2       configured to  
3            change a state of said virtual path to down;  
4            forward said failure message to adjacent nodes comprising said virtual path;  
5            initiate a timer for receiving a response to said forwarded failure message;  
6            if said timer expires before said response to said forwarded failure message is  
7            received,  
8            release resources of said virtual path; and  
9            if said response to said forwarded failure message is received before said timer  
10            expires,  
11            stop said timer, and  
12            release resources of said virtual path.

1       44. The network element of claim 32, wherein said processor is further  
2       configured to  
3            said network element is configured as said second node, and  
4            said network element receives said failure message.

1       45. The network element of claim 44, wherein said processor is further  
2       configured to  
3            acknowledge said failure message;  
4            change a state of said virtual path to down; and  
5            release resources of said virtual path.

1       46. The network element of claim 36, wherein  
2       said network element is configured as one of said intermediate nodes, and  
3       said network element receives said resource request packet.

1       47. The network element of claim 46, wherein said processor is further  
2 configured to  
3       if said resource request packet includes at least one error,  
4           copy said resource request packet to a first resource response packet,  
5           decrement a hop count field in said first resource response packet,  
6           add an error code to said first resource response packet, and  
7           respond with said first resource response packet; and  
8       if said resource request packet includes no errors,  
9           allocate a resource to said virtual path,  
10          increment a hop count field in said resource request packet,  
11          forward said resource request packet to an adjacent node having a  
12           resource necessary to support said virtual path, and  
13           wait for a second resource response packet from said adjacent node.

1       48. The network element of claim 47, wherein said processor is further  
2 configured to  
3       if said second resource response packet is not received within a predetermined  
4           time interval,  
5           release said resource allocated to said virtual path, and  
6           forward a negative acknowledgment to said first node.

1       49. The network element of claim 47, wherein said processor is further  
2 configured to  
3       if said second resource response packet is received with at least one error,  
4           release said resources allocated to said virtual path,  
5           decrement a hop count field in said second resource response packet,  
6           and  
7           forward said second resource response packet to said first node; and  
8       if said second resource response packet is received with no errors,  
9           determine if said second resource response packet includes a valid list  
10           of a plurality of ports.

1       50. The network element of claim 49, wherein said processor is further  
2 configured to

3           if said list of said plurality of ports is invalid,  
4                   release resources allocated to said virtual path, and  
5                   forward a negative acknowledgement to said first node;  
6           if said list of said plurality of ports is valid,  
7                   determine if said plurality of ports is available;  
8           if said plurality of ports is available,  
9                   assign said plurality of ports to said virtual path, and  
10                  update said virtual path information in a node database;  
11           if said plurality of ports is not available,  
12                  add an error code to said second resource response packet;  
13                  decrement a hop count field in said second resource response packet; and  
14                  forward said second resource response packet to said first node.

1       51. The network element of claim 46, wherein said processor is further  
2 configured to

3           if a state of said virtual path is one of ‘restoring’ and ‘deleting’,  
4                  copy said resource request packet to said first resource response  
5                  packet,  
6                  decrement said hop count field in said first resource response packet,  
7                  add an error code of to said first resource response packet, and  
8                  respond with said first resource response packet.

1       52. The network element of claim 36, wherein  
2       network element is configured as said second node, and  
3       said network element receives said resource request packet.

1       53. The network element of claim 52, wherein said processor is further  
2 configured to

3           if said resource request packet includes invalid information,  
4                  copy said resource request packet to a third resource response packet,  
5                  decrement a hop count field in said third resource response packet,

6                   add an error code to said third resource response packet, and  
7                   respond with said third resource response packet; and  
8                   if said resource request packet includes valid information,  
9                   determine if a resource is available for said virtual path.

1           54. The network element of claim 53, wherein said processor is further  
2 configured to

3                   if said resource is available for said virtual path,  
4                   copy said resource request packet to said third resource response  
5                   packet,  
6                   allocate said resource to said virtual path,  
7                   update said virtual path information in a node database,  
8                   decrement a hop count field in said third resource response packet,  
9                   add a list of a plurality of ports to said third resource response packet,  
10                  and  
11                  respond with said third resource response packet.

1           55. The network element of claim 53, wherein said processor is further  
2 configured to

3                   if said resource is not available for said virtual path,  
4                   copy said resource request packet to said third resource response  
5                   packet,  
6                   decrement said hop count field in said third resource response packet,  
7                   add an error code to said third resource response packet, and  
8                   respond with said third resource response packet.

1           56. The network element of claim 52, wherein said processor is further  
2 configured to

3                   if a state of said virtual path is one of ‘restoring’ and ‘deleting’,  
4                   copy said resource request packet to said third resource response  
5                   packet,  
6                   decrement said hop count field in said third resource response packet,  
7                   add an error code to said third resource response packet, and  
8                   respond with said third resource response packet.

1        57. A computer system for restoring a virtual path in an optical network,  
2 said computer system comprising:

3            means for identifying a plurality of nodes with resources, wherein said nodes  
4            with resources are ones of said nodes having a resource necessary to  
5            support said virtual path; and  
6            means for identifying an alternate physical path, said alternate physical path  
7            comprising ones of said nodes with resources.

1        58. The computer system of claim 57, further comprising:

2            means for restoring said virtual path using said alternate physical path.

1        59. The computer system of claim 57, wherein said restoring is done by  
2            means for configuring said alternate physical path by establishing a  
3            communication connection between said ones of said nodes with  
4            resources; and

5            means for provisioning said virtual path over said alternate physical path.

1        60. The computer system of claim 58, further comprising:

2            means for detecting a failure in said virtual path;  
3            said detection of said failure is done by receiving a failure message packet;  
4            said virtual path is provisioned on a physical path between a first and a second  
5            node of said optical network;  
6            said optical network comprises said nodes;  
7            each one of said nodes is coupled to at least one another of said nodes by a  
8            plurality of optical links;  
9            said physical path between said first and said second node comprises a  
10            plurality of intermediate nodes; and  
11            each one of said nodes is coupled to at least one another of said nodes in a  
12            mesh topology.

1        61. The computer system of claim 60, wherein said restoring of said  
2            virtual path is completed in less than 2 seconds.

1       62. The computer system of claim 60, wherein said restoring of said virtual  
2 path is completed in less than 250 milliseconds.

1       63. The computer system of claim 60, wherein said first node receives said  
2 failure message packet.

1       64. The computer system of claim 63, further comprising:  
2           (i) means for changing a state of said virtual path to restoring;  
3           (ii) means for identifying an adjacent node with required  
4                   bandwidth for said virtual path;  
5           (iii) means for forwarding a resource request packet to said adjacent  
6                   node with required bandwidth for said virtual path;  
7           (iv) means for waiting for a resource response packet for a  
8                   predetermined time interval; and  
9           means for repeating steps (ii) – (iv) for a predefined threshold times if said  
10           resource response packet is not received within said predetermined  
11           time interval.

1       65. The computer system of claim 64, further comprising:  
2           means for generating a network alarm if said resource response packet is not  
3           received within said predefined threshold time.

1       66. The computer system of claim 64, further comprising:  
2           means for waiting until responses to all resource request packets are received  
3                   if said resource response packet is received with at least one error; and  
4           means for determining if a list of allocated ports in said resource response  
5                   packet is valid if said resource response packet is received with no  
6                   errors.

1       67. The computer system of claim 66, further comprising:  
2           means for provisioning said virtual path on said allocated ports if said list of  
3                   allocated port is valid; and  
4           means for generating a network alarm if said list of allocated ports is invalid.

1       68.    The computer system of claim 66, further comprising:  
2       means for generating a network alarm if responses to all resource request  
3       packets are received with at least one error.

1       69.    The computer system of claim 65, wherein said predetermined time  
2       interval and predefined threshold are dynamically calculated by said network.

1       70.    The computer system of claim 60, wherein one of said intermediate  
2       nodes receives said failure message.

1       71.    The computer system of claim 70, further comprising:  
2       means for changing a state of said virtual path to down;  
3       means for forwarding said failure message to adjacent nodes comprising said  
4       virtual path;  
5       means for initiating a timer for receiving a response to said forwarded failure  
6       message;  
7       means for releasing resources of said virtual path if said timer expires before  
8       said response to said forwarded failure message is received;  
9       means for stopping said timer if said response to said forwarded failure  
10      message is received before said timer expires; and  
11      means for releasing resources of said virtual path if said response to said  
12      forwarded failure message is received before said timer expires.

1       72.    The computer system of claim 60, wherein said second node receives  
2       said failure message.

1       73.    The computer system of claim 72, further comprising:  
2       means for acknowledging said failure message;  
3       means for changing a state of said virtual path to down; and  
4       means for releasing resources of said virtual path.

1       74.    The computer system of claim 64, wherein one of said intermediate  
2       nodes receives said resource request packet.

1       75. The computer system of claim 74, further comprising:  
2       means for copying said resource request packet to a first resource response  
3                packet if said resource request packet includes at least one error;  
4       means for decrementing a hop count field in said first resource response  
5                packet if said resource request packet includes at least one error;  
6       means for adding an error code to said first resource response packet if said  
7                resource request packet includes at least one error;  
8       means for responding with said first resource response packet if said resource  
9                request packet includes at least one error;  
10      means for allocating a resource to said virtual path if said resource request  
11                packet includes no errors;  
12      means for incrementing a hop count field in said resource request packet if  
13                said resource request packet includes no errors;  
14      means for forwarding said resource request packet to an adjacent node having  
15                a resource necessary to support said virtual path if said resource  
16                request packet includes no errors; and  
17      means for waiting for a second resource response packet from said adjacent  
18                node if said resource request packet includes no errors.

1       76. The computer system of claim 75, further comprising:  
2       means for releasing said resource allocated to said virtual path if said second  
3                resource response packet is not received within a predetermined time  
4                interval; and  
5       means for forwarding a negative acknowledgment to said first node if said  
6                second resource response packet is not received within a  
7                predetermined time interval.

1       77. The computer system of claim 75, further comprising:  
2       means for releasing said resources allocated to said virtual path if said second  
3               resource response packet is received with at least one error;  
4       means for decrementing a hop count field in said second resource response  
5               packet if said second resource response packet is received with at least  
6               one error;  
7       means for forwarding said second resource response packet to said first node if  
8               said second resource response packet is received with at least one  
9               error; and  
10      means for determining if said second resource response packet includes a valid  
11               list of a plurality of ports if said second resource response packet is  
12               received with no errors.

1       78. The computer system of claim 77, further comprising:  
2       means for releasing resources allocated to said virtual path if said list of said  
3               plurality of ports is invalid;  
4       means for forwarding a negative acknowledgement to said first node if said  
5               list of said plurality of ports is invalid;  
6       means for determining if said plurality of ports is available if said list of said  
7               plurality of ports is valid;  
8       means for assigning said plurality of ports to said virtual path if said plurality  
9               of ports is available;  
10      means for updating said virtual path information in a node database if said  
11               plurality of ports is available;  
12      means for adding an error code to said second resource response packet if said  
13               plurality of ports is not available;  
14      means for decrementing a hop count field in said second resource response  
15               packet; and  
16      means for forwarding said second resource response packet to said first node.

1       79. The computer system of claim 74, further comprising:  
2       means for copying said resource request packet to said first resource response  
3            packet if a state of said virtual path is one of ‘restoring’ and ‘deleting’;  
4       means for decrementing said hop count field in said first resource response  
5            packet if a state of said virtual path is one of ‘restoring’ and ‘deleting’;  
6       means for adding an error code of to said first resource response packet if a  
7            state of said virtual path is one of ‘restoring’ and ‘deleting’; and  
8       means for responding with said first resource response packet if a state of said  
9            virtual path is one of ‘restoring’ and ‘deleting’.

1       80. The computer system of claim 64, wherein said second node receives  
2       said resource request packet.

1       81. The computer system of claim 80, further comprising:  
2       means for copying said resource request packet to a third resource response  
3            packet if said resource request packet includes invalid information;  
4       means for decrementing a hop count field in said third resource response  
5            packet if said resource request packet includes invalid information;  
6       means for adding an error code to said third resource response packet if said  
7            resource request packet includes invalid information;  
8       means for responding with said third resource response packet if said resource  
9            request packet includes invalid information; and  
10      means for determining if a resource is available for said virtual path if said  
11       resource request packet includes valid information.

1       82. The computer system of claim 81, further comprising:  
2       means for copying said resource request packet to said third resource response  
3            packet if said resource is available for said virtual path;  
4       means for allocating said resource to said virtual path if said resource is  
5            available for said virtual path;  
6       means for updating said virtual path information in a node database if said  
7            resource is available for said virtual path;  
8       means for decrementing a hop count field in said third resource response  
9            packet if said resource is available for said virtual path;  
10      means for adding a list of a plurality of ports to said third resource response  
11            packet if said resource is available for said virtual path; and  
12      means for responding with said third resource response packet.

1       83. The computer system of claim 81, further comprising:  
2       means for copying said resource request packet to said third resource response  
3            packet if said resource is not available for said virtual path;  
4       means for decrementing said hop count field in said third resource response  
5            packet if said resource is not available for said virtual path;  
6       means for adding an error code to said third resource response packet if said  
7            resource is not available for said virtual path; and  
8       means for responding with said third resource response packet.

1       84. The computer system of claim 80, further comprising:  
2       means for copying said resource request packet to said third resource response  
3            packet if a state of said virtual path is one of ‘restoring’ and ‘deleting’;  
4       means for decrementing said hop count field in said third resource response  
5            packet if a state of said virtual path is one of ‘restoring’ and ‘deleting’;  
6       means for adding an error code to said third resource response packet if a state  
7            of said virtual path is one of ‘restoring’ and ‘deleting’; and  
8       means for responding with said third resource response packet.

1        85. A computer program product for restoring a virtual path in an optical  
2 network, encoded in computer readable media, said program product comprising a set  
3 of instructions executable on a computer system, said set of instructions configured to  
4        identify a plurality of nodes with resources, wherein said nodes with resources  
5        are ones of said nodes having a resource necessary to support said  
6        virtual path; and  
7        identifying an alternate physical path, said alternate physical path comprising  
8        ones of said nodes with resources.

1        86. The computer program product of claim 85, wherein said set of  
2 instructions is further configured to  
3        restore said virtual path using said alternate physical path.

1        87. The computer program product of claim 85, wherein said set of  
2 instructions is further configured to  
3        configure said alternate physical path by establishing a communication  
4        connection between said ones of said nodes with resources; and  
5        provision said virtual path over said alternate physical path.

1        88. The computer program product of claim 85, wherein said set of  
2 instructions is further configured to  
3        detect a failure in said virtual path;  
4        said detection of said failure is done by receiving a failure message packet;  
5        said virtual path is provisioned on a physical path between a first and a second  
6        node of said optical network;  
7        said optical network comprises said nodes;  
8        each one of said nodes is coupled to at least one another of said nodes by a  
9        plurality of optical links;  
10      said physical path between said first and said second node comprises a  
11      plurality of intermediate nodes; and  
12      each one of said nodes is coupled to at least one another of said nodes in a  
13      mesh topology.

1        89.    The computer program product of claim 88, wherein said set of  
2 instructions is further configured to restore said virtual path in less than 2 seconds.

1        90.    The computer program product of claim 88, wherein said set of  
2 instructions is further configured to restore said virtual path in less than 250  
3 milliseconds.

1        91.    The method of claim 88, wherein said first node receives said failure  
2 message packet.

1        92.    The computer program product of claim 91, wherein said set of  
2 instructions is further configured to  
3                (i)    change a state of said virtual path to restoring;  
4                (ii)    identify an adjacent node with required bandwidth for said  
5                        virtual path;  
6                (iii)    forward a resource request packet to said adjacent node with  
7                        required bandwidth for said virtual path;  
8                (iv)    wait for a resource response packet for a predetermined time  
9                        interval; and  
10                (v)    if said resource response packet is not received within said  
11                        predetermined time interval,  
12                        repeat steps (ii) – (iv) for a predefined threshold times.

1        93.    The computer program product of claim 92, wherein said set of  
2 instructions is further configured to  
3                if said resource response packet is not received within said predefined  
4                        threshold time,  
5                        generate a network alarm.

1        94.    The computer program product of claim 94, wherein said set of  
2 instructions is further configured to  
3                if said resource response packet is received with at least one error,  
4                        wait until responses to all resource request packets are received; and

5 if said resource response packet is received with no errors,  
6 determine if a list of allocated ports in said resource response packet is  
7 valid.

1 95. The computer program product of claim 94, wherein said set of  
2 instructions is further configured to  
3 if said list of allocated port is valid,  
4 provision said virtual path on said allocated ports; and  
5 if said list of allocated ports is invalid,  
6 generate a network alarm.

1 96. The computer program product of claim 93, wherein said set of  
2 instructions is further configured to  
3 if responses to all resource request packets are received with at least one error,  
4 generate a network alarm.

1 97. The computer program product of claim 88, wherein said  
2 predetermined time interval and predefined threshold are dynamically calculated by  
3 said network.

1 98. The computer program product of claim 88, wherein one of said  
2 intermediate nodes receives said failure message.

1       99. The computer program product of claim 88, wherein said set of  
2 instructions is further configured to  
3       change a state of said virtual path to down;  
4       forward said failure message to adjacent nodes comprising said virtual path;  
5       initiate a timer for receiving a response to said forwarded failure message;  
6       if said timer expires before said response to said forwarded failure message is  
7       received,  
8       release resources of said virtual path; and  
9       if said response to said forwarded failure message is received before said timer  
10      expires,  
11      stop said timer, and  
12      release resources of said virtual path.

1       100. The computer program product of claim 88, wherein said second node  
2 receives said failure message.

1       101. The computer program product of claim 100, wherein said set of  
2 instructions is further configured to  
3       acknowledge said failure message;  
4       change a state of said virtual path to down; and  
5       release resources of said virtual path.

1       102. The computer program product of claim 92, wherein one of said  
2 intermediate nodes receives said resource request packet.

1       103. The computer program product of claim 92, wherein said set of  
2 instructions is further configured to  
3       if said resource request packet includes at least one error,  
4           copy said resource request packet to a first resource response packet,  
5           decrement a hop count field in said first resource response packet,  
6           add an error code to said first resource response packet, and  
7           respond with said first resource response packet; and  
8       if said resource request packet includes no errors,

9           allocate a resource to said virtual path,  
10          increment a hop count field in said resource request packet,  
11          forward said resource request packet to an adjacent node having a  
12                resource necessary to support said virtual path, and  
13          wait for a second resource response packet from said adjacent node.

1           104. The computer program product of claim 103, wherein said set of  
2        instructions is further configured to  
3                if said second resource response packet is not received within a predetermined  
4                time interval,  
5                release said resource allocated to said virtual path, and  
6                forward a negative acknowledgment to said first node.

1           105. The computer program product of claim 103, wherein said set of  
2        instructions is further configured to  
3                if said second resource response packet is received with at least one error,  
4                release said resources allocated to said virtual path,  
5                decrement a hop count field in said second resource response packet,  
6                and  
7                forward said second resource response packet to said first node; and  
8                if said second resource response packet is received with no errors,  
9                determine if said second resource response packet includes a valid list  
10                of a plurality of ports.

1           106. The computer program product of claim 105, wherein said set of  
2        instructions is further configured to  
3                if said list of said plurality of ports is invalid,  
4                release resources allocated to said virtual path, and  
5                forward a negative acknowledgement to said first node;  
6                if said list of said plurality of ports is valid,  
7                determine if said plurality of ports is available;  
8                if said plurality of ports is available,  
9                assign said plurality of ports to said virtual path, and  
10                update said virtual path information in a node database;

11 if said plurality of ports is not available,  
12 add an error code to said second resource response packet;  
13 decrement a hop count field in said second resource response packet; and  
14 forward said second resource response packet to said first node.

1 107. The computer program product of claim 102, wherein said set of  
2 instructions is further configured to

3 if a state of said virtual path is one of 'restoring' and 'deleting',  
4 copy said resource request packet to said first resource response  
5 packet,  
6 decrement said hop count field in said first resource response packet,  
7 add an error code of to said first resource response packet, and  
8 respond with said first resource response packet.

1 108. The computer program product of claim 92, wherein said second node  
2 receives said resource request packet.

1 109. The computer program product of claim 108, wherein said set of  
2 instructions is further configured to

3 if said resource request packet includes invalid information,  
4 copy said resource request packet to a third resource response packet,  
5 decrement a hop count field in said third resource response packet,  
6 add an error code to said third resource response packet, and  
7 respond with said third resource response packet; and  
8 if said resource request packet includes valid information,  
9 determine if a resource is available for said virtual path.

1           110. The computer program product of claim 109, wherein said set of  
2 instructions is further configured to  
3           if said resource is available for said virtual path,  
4            copy said resource request packet to said third resource response  
5            packet,  
6           allocate said resource to said virtual path,  
7           update said virtual path information in a node database,  
8           decrement a hop count field in said third resource response packet,  
9           add a list of a plurality of ports to said third resource response packet,  
10           and  
11           respond with said third resource response packet.

1           111. The computer program product of claim 108, wherein said set of  
2 instructions is further configured to  
3           if said resource is not available for said virtual path,  
4            copy said resource request packet to said third resource response  
5            packet,  
6           decrement said hop count field in said third resource response packet,  
7           add an error code to said third resource response packet, and  
8           respond with said third resource response packet.

1           112. The computer program product of claim 24, wherein said set of  
2 instructions is further configured to  
3           if a state of said virtual path is one of ‘restoring’ and ‘deleting’,  
4            copy said resource request packet to said third resource response  
5            packet,  
6           decrement said hop count field in said third resource response packet,  
7           add an error code to said third resource response packet, and  
8           respond with said third resource response packet.